The Electrical Load List

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Presentation Objectives

- Understand why we need electrical Load Lists (ELL).

- Where does the date come from to populate an ELL?

- Why are we stuck with spreadsheets?

- What is the data used for?

- How accurate is the ELL anyway?

Sometimes the objectives that I think are important are not necessarily the same that you think are important. Oops… Lets discuss so I can do better next time.

In the Beginning

In the big scheme of things there is a natural progression to every Petro-Chem project. First on the project is always the Process Engineer.

In a **greenfield project**, the Process Engineer has to create the process from input of basic ingredients, to mix everything together, to finished output. Until the Process Engineer if finished, nothing can happen.

The Process Engineer designs the process with a specific **maximum process capacity** (MPC) in mind. This means the plant has a nameplate capacity of XX mbd.

Important concept!

Questions.

Question #1 Do we ever design a process that can be pushed to a higher capacity than nameplate capacity???

Question #2 Does the end users ever "push" the plant beyond nameplate capacity? I.E. get more throughput than what the nameplate says??? How does he do it?

Question #3 What does it mean to say the plant is running at 95% capacity?

In the Beginning... Cont.

The Process Engineer creates the process flow diagrams (PFD's) and the process and instrumentation diagrams (P&ID's). The Electrical Engineer has no hand in this work.

Once the PFD's and P&ID's are signed off / accepted / approved, does the Electrical Engineer start his work.

Let's make it clear, in Petro/Chem work, Electrical Engineers follow, they do not lead.

In the big scheme of things, Process Engineers are first, EE's are second to last, and in last place is the I&C Engineer. This is the Petro/Chem order that will never change.

Our Job.

The data to populate an ELL comes from two sources. They are as follows.

1. The P&ID's

2. Process Support Equipment and ancillary items.

P&ID's

The Process Engineer has selected pumps to do the work of moving product about. The pump selection is based on flow and head. Driving the pump is an electric motor. Hopefully the motor is started DOL as against a VFD starter. **Motor starting and control method should be on the P&ID's.**

The size could be in BHP or HP Either way, we handle the data and move on.

BHP = Break Horse Power

HP = Horse Power

The difference being, BHP is the calculated requirements needed to keep the process at **maximum process capacity**. HP is the size of a standard 460V NEMA frame motor.

Electric Load List.pdf

Process Support Equipment

The process support equipment consists of **everything electrical** to **support** and **keep the facility running**. The **usual items** are as follows.

1. Buildings including the PCR
2. Inst. rack power
3. Lighting, Inst. & Misc. field power panels
4. Heat tracing panels
5. Motor & equipment heaters
6. 120V normal and 480V welding receptacles
7. Gai-Tronics power
8. CCTV power
9. Card readers
10. UPS & DC power
11. Etc.,

Questions

Question #4 If the process support equipment list is not on the P&ID's, where does it come from?

Question #5 What design guide should we use?

Question #6 Is it safe?

Pitfall

The pitfall is to do with panels.

It is usual to put on the ELL the xfmr feeding the panel. For example, in the PCR is a lighting panel with a 30KVA xfmr feeding it. So I put 30KVA on the ELL and on I go.

Looking at the wiring diagram all I have is 7 lighting ckts out of a 36 ckt panel. How much of that 30KVA am I actually using???

The same PCR has a 15 KVA xfmr feeding 5 recept ckts out of a 30 ckt panel?

Or five areas of a new facility each assigned 1 X Lighting, 1 X recept & 1 X Misc. panels and xfmrs. All done for conservatism and CYA to order the MCC's.

ELL Basics

One of the few good places to go for ELL fundamental guidance is the *Handbook of Electrical Engineers*, chapter 1. and

http://www.openelectrical.org/wiki/index.php?title=Load_Schedule

ELL Basics… Cont.

Get all the P&ID's in a stack. Turn to the first P&ID and start at the left and work your way to the right of each drawing. Listed either at the top or the bottom of the drawing are the electric motors and heaters. Data listed is as follows.

1. Motor Number
2. Motor Description
3. BHP and/or HP
4. P&ID drawing number

No_001.xlsx

In simple parlance, P&ID's rule the project.

ELL Basics... Cont.

The goal is to have **some semblance of order** in the ELL making it simple and easy to locate equipment items.

1. Keep the equipment in P&ID drawing order

2. Put the equipment in alphanumerical order

3. Put the equipment in MCC then numerical order

4. Put P&ID above process support equipment

5. Put motors then heaters followed by process support equipment

Straight away we are facing the limitations of spreadsheets as against data base (Access, dBase, etc.,) work.

Spreadsheets are so 1980's. When will we progress on???

ELL Basics... Cont.

The **customary approach** for equipment separations is the following.

1. If an 'A' & 'B' motor - All 'A' motors on 'A' MCC/SWGR line-up and all 'B' motors on 'B' MCC/SWGR line-up.

2. If an 'A', 'B' & 'C' motor - 'A' & 'C' motors on 'A' MCC/SWGR line-up and 'B' motors on 'B' MCC/SWGR line-up.

3. If an 'A', 'B', 'C' & 'D' motor - 'A' & 'C' motors on 'A' MCC/SWGR line-up and 'B' & 'D' motors on 'B' MCC/SWGR line-up.

4. Single loads spread equally between 'A' & 'B' MCC/SWGR to **balance out the overall loads**.

Follow company design procedure, if not **document it.**

Important concept! 14

Questions... More of Them!

Question #7. Who actually sizes the motor based on the P&ID data of process flow and head? Is it the Electrical Engineer? Electrical Designer? Process Engineer? If not this lot then who?

Question #8. When is the preliminary and final data available?

Question #9. Can motor size change between preliminary and final data?

Our Job

Our job is to assemble the ELL as **quickly as possible** since we have to order **long lead items** such as a fully populated and functioning PCR with associated SWGR, MCC's, bus duct for the various step-down transformers, relays, etc.,

To do our job we need the data to **create an ELL** that will feed data into the **electrical studies** that will ensure we are buying the correctly sized and rated equipment.

Our Job... Cont.

Greenfield – Since everything is new we are going to create a new electrical system all the way from power source to the lowest user. That means creating an ELL and doing studies from scratch.

Brownfield – Blending new work into an existing facility is always more challenging. Too often ELL's and studies are usually old, out of date and highly suspect.

Regardless of location type, we have a job to do. And to do that job we revert to **good engineering practices** and procedures which include **default assumptions** based upon **sound justifiable judgment**.

The key point is, **it is documented.**

Our Job… Cont.

Therefore, the ELL is usually started with default data, default calculations, default assumptions.

The key point is, **it is documented.**

As the job progresses the data will change as the P&ID's change. Once the P&ID's are issued for construction, more than likely, the ELL will not change much until final certified data is received and the ELL is updated along with the studies.

The key point is, **it is documented.**

This preliminary and final approach falls in line with the preliminary and the final electrical studies.

BHP

If the data on the P&ID's list motors in BHP, then we need to convert it to HP as that is how we look at things in the NEC world.

Say the P&ID lists the required motor value at 18BHP. What do I do now?

Assumption #1. The motor BHP is ≈ 85% of motor nameplate HP

This assumption is based upon the fact the motor starting curve has to be greater than the load curve to be able to accelerate the equipment up to full speed.

This assumption is also based on API 610 Table 12 middle value.

HP

The rule of thumb is the motor nameplate HP should be about 10 – 15% above process required BHP.

HP

The corollary is:-

Assumption #2. The motor nameplate HP is ≈ 115% of BHP

This assumption is based upon the fact the motor starting curve has to be greater than the load curve to be able to accelerate the equipment up to full speed.
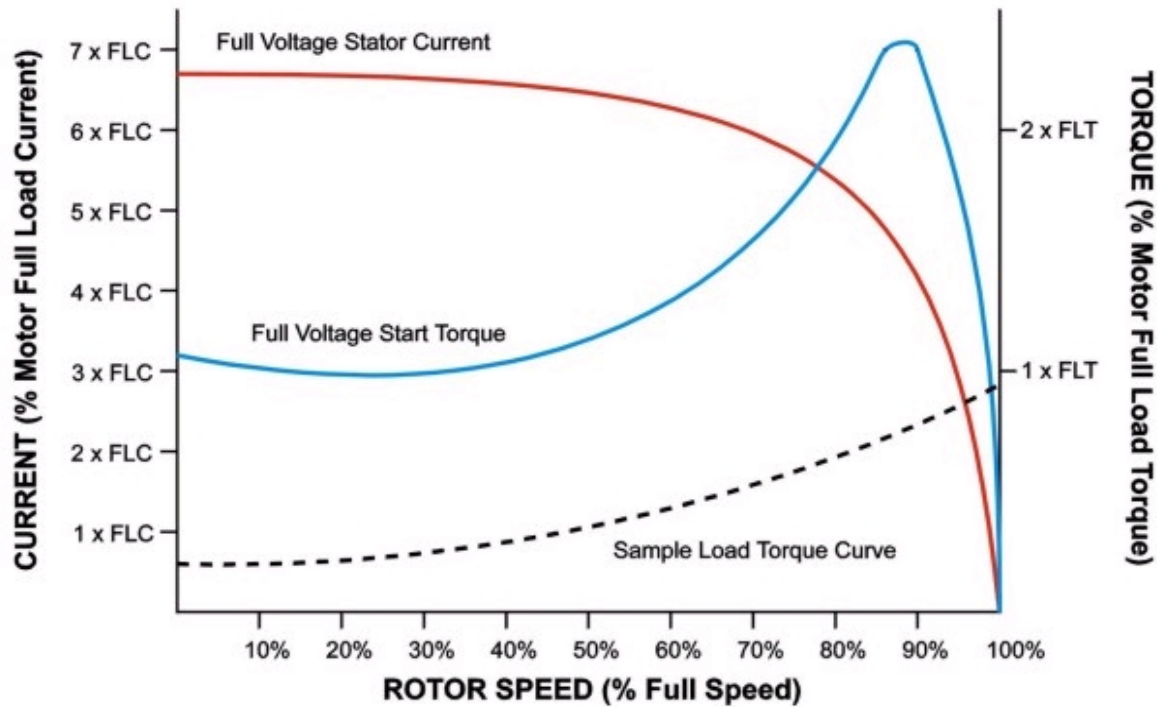
This assumption is also based on API 610 Table 12 middle value.

Assumption 1 & 2 are valid since we do not size motors: the pump vendor does. They tell us the correct size after the PO is placed and certified data is received. Until then everything is preliminary and all we are trying to do is get into the ballpark.

BHP

Say the P&ID lists the required motor value at 18BHP. What do I do now?

Assumption #2. The motor nameplate HP is ≈ 115% of BHP

Therefore 18BHP X 1.15 = 20.7HP

Our preliminary NEMA frame motor would be 25HP as it is the nearest standard NEMA frame motor <u>above</u> the calculated 20.7 value.

However, I would be willing to bet that there is some vendor out there that could use a 20HP motor to do the job. But I do the 25HP as that is per our design guidelines.

ELL… More Columns

Pushing along. I'm taking the equipment data off the P&ID's in drawing order.

A & B motors

TAG #	DESCRIPTION	FLOWSHT	load type hp/kva	HP/KVA VALUE	STATUS C X	I X	S X	LOAD FCTR	DIVERS FCTR
P-421102A	ORF FEED PUMP	20-0032-01	HP	40.0	X			0.85	1.00
P-421102B	ORF FEED PUMP	20-0032-01	HP	40.0			X	0.85	0.10
P-421103A	GF RECYCLE PUMP	20-0032-01	HP	15.0	X			0.85	1.00
P-421103B	GF RECYCLE PUMP	20-0032-01	HP	15.0			X	0.85	0.10
P-421104A	GF FROTH PUMP	20-0032-01	HP	3	X			0.85	1.00
P-421104B	GF FROTH PUMP	20-0032-01	HP	3			X	0.85	0.10

New terms:

1. **CIS**
2. **Load Factor**
3. **Diversity (yep, I'm dropping the word 'factor')**

Mode

It is **customary** to classify all electrical loads as either **Continuous**, **Intermittent** or **Standby** mode. This mode classification is **purely arbitrary** and is not based on any recognized or approved standard. However, continuous and intermittent modes are remarkably similar to the NFPA 70 definitions. But NFPA 70 has nothing remotely close for standby mode.

The practice of classifying items as **Continuous**, **Intermittent** or **Standby** has become entrenched in the Petro/Chem world **without any clear guidance or understanding**.

Continuous Load

Continuous loads are **usually defined** as those that normally operate continuously for long periods of time.

Connection Practices

If there is an 'A', 'B' & 'C' motor, it is **typical** to consider the 'A' & 'B' motors as continuous and the 'C' motor as standby.

If there is an 'A' & 'B' motor, it is **typical** to consider all 'A' motors as continuous loads and all 'B' motors as standby loads.

If there is a single motor or load, after consultation with process, **it shall be designated** as continuous or intermittent load. Single motors or loads cannot be in standby mode.
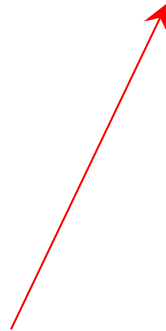
Intermittent Load

Intermittent loads are **usually defined** as those loads that normally operate a fraction of a 24 hour period. The exact period of time is **usually not defined or noted.**

Don't get mixed up with Intermittent duty motors.

In the Petro/Chem world we always go with **continuous duty** motors for all motor operations.

Standby Load

Standby loads are **usually defined** as those loads that are off but ready to run. The **most common** standby use being illustrated as follows. If there is an 'A' & 'B' motor, it is typical to consider all 'A' motors as continuous loads and all 'B' motors as standby loads.

Operation Practices

Under **normal circumstances**, the only time an 'A' & 'B' motor would run at the same time is during transition from using the 'A' pump to using the 'B' pump: as in the following example.

'A' pump is running; turn on 'B' pump resulting in 'A' & 'B' pump running at the same time; then shutting down the 'A' pump leaving only the 'B' pump running. The time period that 'A' & 'B' pumps are running at the same time is usually of a very short duration.

Load Factor (LF)

IEEE Std 141-1993 (Red Book) Clause 2.4.1.3.6 says "Load Factor: The ratio of the average load over a designated period of time to the peak load occurring in that period.

Note that although not part of the official definition, the term load factor is used by some utilities and others to describe the equivalent number of hours per period of the peak or average demand must prevail in order to produce the total energy consumption for the period."

In the Petro/Chem world the LF definition is modified/changed to read as follows. *The ratio of the process BHP value to the motor HP nameplate value. For other loads the load factor is assumed to be 100%.*

NOTE: This document uses the "unofficial" Petro/Chem version of load factor (LF).

Load Factor (LF)… Cont.

Say the P&ID lists the required motor value of 18BHP to achieve maximum process capacity, and our calculation says the provided motor will be 25HP, then the following applies.

Load Factor (LF) = (18/25) = 0.72

This LF value shall continue to be used until final certified data is provided. But by then the electrical equipment is bought, installed and close to full operation.

Load Factor (LF)… Cont.

Say the P&ID lists the motor as 25HP to achieve **maximum process capacity** . Then we assume the Load factor (LF) is 0.85. Which means we are assuming the motor to be operating at 21.25BHP.

Our **default approach** is to use a load factor (LF) of 0.85. This goes back to **Assumption 1 & 2** previously stated.

Therefore, having the BHP can make a difference to the calculations.

Diversity (D)

IEEE Std 141-1993 (Red Book) Clause 2.4.1.3.5 says "Diversity Factor: The ratio of the sum of the individual non-coincident maximum demands of various subdivisions of the system to the maximum demand of the complete system. The diversity factor is always 1 or greater. The (unofficial) term *diversity*, as distinguished from *diversity factor* refers to the percent time available that a machine, piece of equipment, or facility has its maximum or normal load or demand (i.e. a 70% diversity means that the device in question operates at its nominal or maximum load level 70% of the time that it is connected and turned on)."

NOTE: This document uses the "unofficial" term and definition of diversity (D)

Diversity (D)… Cont.

At the moment there is no **technical agreement** as to the value of D, or to its application across **Continuous**, **Intermittent** and **Standby** loads, or to the values used during Feasibility (FEP-1), Concept (FEP-2) and Detailed Scope (FEP-3).

The problem is the EPC company is trying to get long lead electrical equipment on order based on preliminary and best guess data. If the EPC company selects high D values, they will be **safe** and **conservative**. But more than likely incurring higher CAPEX and ongoing OPEX costs. Both not good for the client.

So, what do you do???

Ask the client or make it up and document it.

Diversity (D)... Cont.

Continuous Mode - Diversity (D_C)

Continuous loads have a pretty clear definition as it has to do with loads that are continuously running. Therefore, continuous loads are assigned a diversity of 100% as follows.

$D_C = 1.00$

Diversity (D)… Cont.

Intermittent Mode - Diversity (D_I)

Intermittent loads are a challenge. The two referenced documents use a intermittent diversity of 50%.

1. **So, where does 50% come from?**
2. **What is the underlying justification?**
3. **Or, what operating mode at the plant would have all intermittent loads at 50%?**
4. **Are we doing a copy without thinking?**
5. **Or, is it all about conservatism and CYA?**

I'm thinking this way…

Diversity (D)… Cont.

Intermittent Mode - Diversity (D_I)

Defining the operation point with the following.

1. D_I **for lighting panels,** D_I **= 50% (day/night)**
2. D_I **for receptacle panels,** D_I **= 5% (little usage)**
3. D_I **for mixed usage panels,** D_I **= 30% (little maintenance)**
4. D_I **for UPS & DC systems,** D_I **= 5% (ripple charging)**
5. D_I **for welding receptacles,** D_I **= 5% (nothing going on)**
6. D_I **for HVAC,** D_I **= 50% (two units)**
7. D_I **for Heat tracing,** D_I **= 50% (part time usage)**

And so on as needed and identified.

Diversity (D)… Cont.

Standby Mode - Diversity (D$_S$)

Standby loads should be simple: but aren't. The two referenced documents use a standby diversity of 10%.

1. **So, where does 10% come from?**
2. **What is the underlying justification?**
3. **Or, what operating mode at the plant would have all standby loads at 10%?**
4. **Are we doing a copy without thinking?**
5. **Or, is it all about conservatism and CYA?**

I'm thinking this way… Standby loads are at 0.0% as they are not running.

Load Criticality

You will notice that I am avoiding the topic of Load Criticality which are normally considered to be as follows.

1.   **Normal Loads**

2.   **Essential Loads**

3.   **Critical Loads**

Stepping Back a Moment

Let's step back a moment. What are we trying to do?

1. We are trying to size electrical equipment to provide a safe operating environment for the personnel using the equipment.

2. And provide a cost effective solution to the problem at hand.

Load Formulas (MNRL) #1

Maximum normal running load (MNRL) is the summation of all continuous loads (CL) and intermittent loads (IL) multiplied by diversity (D_I).

$$MNRL = \sum CL + \sum (IL \times D_I)$$

Where CL & IL are at the LF & D point.

Maximum Normal Running Load is assumed to occur when **maximum process capacity** is achieved.

Load Formulas (MNRL) #2

Maximum Normal Running Load (MNRL) is the summation of all continuous loads (CL), intermittent loads (IL) multiplied by diversity (D_I) and standby loads (SL) multiplied by diversity (D_S).

$$MNRL = \sum CL + \sum (IL \times D_I) + \sum (SL \times D_S)$$

Where CL, IL & SL are at the LF & D point

Maximum Normal Running Load (MNRL) is assumed to occur when maximum process capacity is achieved.

More conservatism, more CYA, more cost.

Load Formulas (MD)

Maximum demand (MD) occurs at maximum normal running load (MNRL) plus future demand (FD) plus a 10% margin (FD X 10%).

$$MD = MNRL + \sum FD + (\sum FD \times 10\%)$$

Where FD is a **documented** value.

Maximum Normal Running Load (MNRL) is assumed to occur when **maximum process capacity** is achieved.

Load Formulas (CD)

Connected demand (CD) is **not a process operating point**. It is a summation of all connected loads.

$$CD = \sum CL + \sum IL + \sum SL$$

Where CL, IL & SL are at equipment nameplate values

Motor Data

Moving on…

FLOWSHT	load type hp/kva	HP/KVA VALUE	STATUS C X	I X	S X	LOAD FCTR	DIVERS FCTR	LOOKUP DATA SF	FLA	PF	EFF
20-0032-01	HP	40.0	X			0.85	1.00	1.15	52.0	0.86	0.94
20-0032-01	HP	40.0			X	0.85	0.10	1.15	52.0	0.86	0.94
20-0032-01	HP	15.0	X			0.85	1.00	1.15	21.0	0.86	0.91
20-0032-01	HP	15.0			X	0.85	0.10	1.15	21.0	0.86	0.91
20-0032-01	HP	3	X			0.85	1.00	1.15	4.8	0.80	0.86
20-0032-01	HP	3			X	0.85	0.10	1.15	4.8	0.80	0.86

Two Questions.

Question #10. Why do I need a SF of 1.15 when I have a LF of 0.72? Is it physically possible to push the motor into the SF area?

Question #11. If I want the project to be per the NEC, what does that mean for motor data? Where do I go to keep in compliance with the NEC?

Motor Data… Cont.

The following is per the 2014 NEC. Note, no Eff or PF.

460V MOTOR FLA FROM NEC TABLE 430-250		
VOLTAGE	HP	FLA
460	1/2	1.1
460	3/4	1.6
460	1	2.1
460	1 1/2	3.0
460	2	3.4
460	3	4.8
460	5	7.6
460	7 1/2	11.0
460	10	14.0
460	15	21.0
460	20	27.0
460	25	34.0
460	30	40.0
460	40	52.0
460	50	65.0
460	60	77.0
460	75	96.0
460	100	124.0
460	125	156.0
460	150	180.0
460	200	240.0

Electrical Design Criteria says to comply with NEC.

But is this really what I shall be buying?

If my standard is to get API 841 motors, what values do I use? And how close are they to the NEC?

Motor Data... Cont.

Taken from Siemens 2015-D81.2 NEMA Motors Catalog

| Siemens SD100 IEEE 841 NEMA Premium AL Rotor						
HP	RPM	Frame	Voltage	FLA	Nom Eff	PF
1	1800	143T	460	1.40	85.50	0.78
1.5	1800	145T	460	2.10	86.50	0.77
2	1800	145T	460	2.80	86.50	0.77
3	1800	182T	460	4.00	89.50	0.78
5	1800	184T	460	6.50	89.50	0.80
7.5	1800	213T	460	9.70	91.70	0.79
10	1800	215T	460	12.50	91.70	0.82
15	1800	254T	460	19.00	92.40	0.80
20	1800	256T	460	25.00	93.00	0.81
25	1800	284T	460	30.00	93.60	0.83
30	1800	286T	460	35.00	93.60	0.86
40	1800	324T	460	46.00	94.10	0.87
50	1800	326T	460	58.00	94.50	0.85
60	1800	364T	460	68.00	95.00	0.87
75	1800	365T	460	85.00	95.40	0.87
100	1800	405T	460	113.00	95.40	0.87
125	1800	444T	460	143.00	95.40	0.86
150	1800	445T	460	170.00	95.80	0.86
200	1800	447T	460	226.00	96.20	0.86

PF calculated. Also note the difference from NEC ampacity.

Motors operate at maximum process capacity, not nameplate, so what do we do?

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Motor Data... Cont.
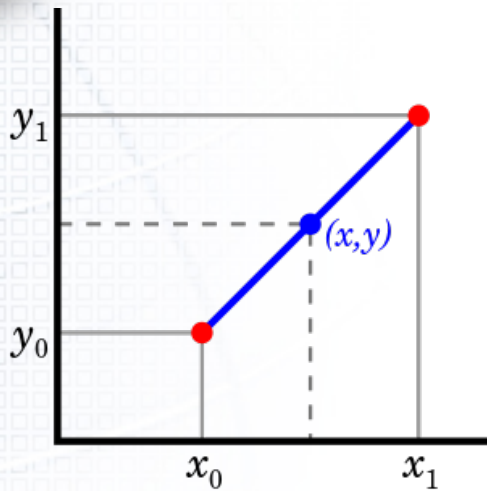
Linear Interpolation...

If the two known points are given by the coordinates and , the linear interpolant is the **straight line** between these points. For a value *x* in the interval , the value *y* along the straight line is given from the equation

$$\frac{y - y_0}{x - x_0} = \frac{y_1 - y_0}{x_1 - x_0}$$

The key point being along the **straight line**. If the line **is not straight**, then this formula is of no use.

Some people use linear interpolation when calculating motor power factor and efficiency at **maximum process capacity**. Since the power factor and efficiency curve **are not straight**, then a degree of error is introduced.

Motor Data... Cont.
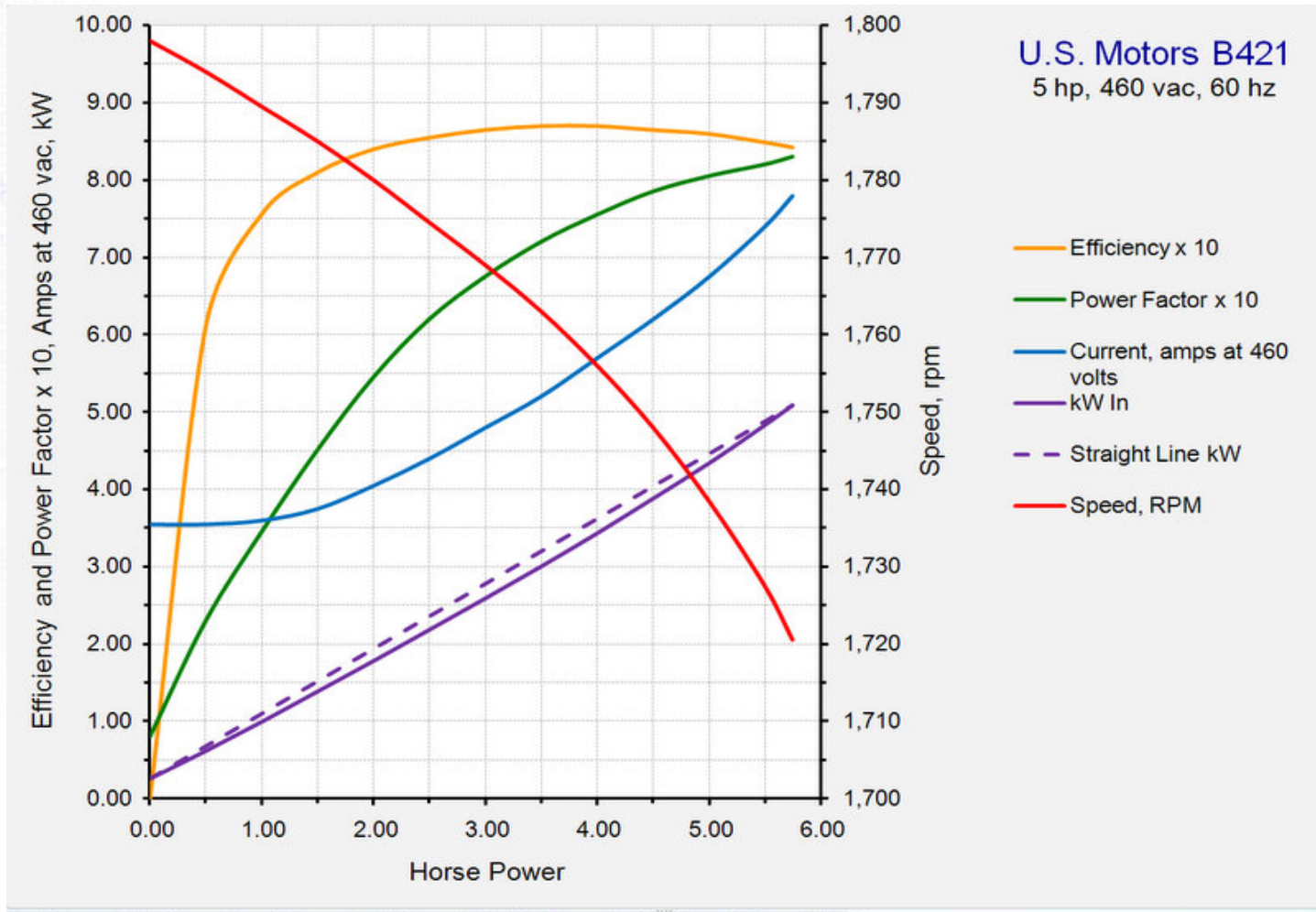
Table 1

Taken from the P&ID's

Row	ID	Description	P&ID	BK HP	BK KVA
1	P-101A	Bottoms Sump Pump	D-101-10001A	7	
2	P-101B	Bottoms Sump Pump	D-101-10001A	7	
3	P-102A	Bottoms End Pump	D-101-10001A	13	
4	P-102B	Bottoms End Pump	D-101-10001A	13	
5	P-103A	Recycle Pump	D-101-10001B	77	
6	P-103B	Recycle Pump	D-101-10001B	77	
7	P-104	Sump Pump	D-101-10002C	33	
8	P-105	Sump Bottoms Pump	D-101-10003A	130	
9	HTR-001	Heater 001	D-102-10001A		50
10	HTR-002	Heater 002	D-102-10001B		75

Table 2

Add in Non-P&ID data

Row	ID	Description	P&ID	BK HP	BK KVA	KVA
1	P-101A	Bottoms Sump Pump	D-101-10001A	7		
2	P-101B	Bottoms Sump Pump	D-101-10001A	7		
3	P-102A	Bottoms End Pump	D-101-10001A	13		
4	P-102B	Bottoms End Pump	D-101-10001A	13		
5	P-103A	Recycle Pump	D-101-10001B	77		
6	P-103B	Recycle Pump	D-101-10001B	77		
7	P-104	Sump Pump	D-101-10002C	33		
8	P-105	Sump Bottoms Pump	D-101-10003A	130		
9	HTR-001	Heater 001	D-102-10001A		50	
10	HTR-002	Heater 002	D-102-10001B		75	
11	LP-001	Lighting Panel				50
12	LP-002	Lighting Panel				50
13	UPS-001	Inst UPS				45
14	DC-001	DC Power				30
15	FDR-001A	Control Building Power				500
16	FDR-001B	Control Building Power				500
17	LP-003	Lighting Panel				20
18	LP-004	Lighting Panel				20
19	HVAC-001	HVAC Unit #1				100
20	HVAC-002	HVAC Unit #2				100

Table 2... Cont.

For non-process loads it is **customary** to use the transformer size associated with the load.

Again, this **customary method** can result in a large electrical load associated with panels. This load will not be known until the design is done and the panel loads are summated.

This summation **usually occurs** long after the equipment PO is placed resulting in oversized electrical equipment.

Linear Interpolation

See the difference between eyeballing and calculated linear interpolation.

Eyeballing

BK HP	HP	RPM	PF 50%	PF 60%	PF 75%	PF 80%	PF 100%	Eff 50%	Eff 60%	Eff 75%	Eff 80%	Eff 100%	Guar Min
7	10	1755	63.80	67.00	76.20	78.00	81.70	91.70	91.95	92.20	91.95	91.70	90.20
13	20	1770	65.30	69.00	75.90	76.50	80.50	93.10	93.25	93.40	93.25	93.00	91.70
33	40	1780	75.00	78.00	83.00	83.50	86.00	94.30	94.18	94.10	94.10	94.10	93.60
77	100	1780	80.00	82.50	86.00	86.40	87.00	95.80	95.95	96.00	95.70	95.40	95.00
130	200	1785	76.00	78.50	84.00	84.80	86.00	96.20	96.35	96.50	96.37	96.20	95.80

Linear Interpolation

BK HP	HP	RPM	PF 50%	PF 60%	PF 75%	PF 80%	PF 100%	Eff 50%	Eff 60%	Eff 75%	Eff 80%	Eff 100%	Guar Min
7	10	1755	63.80	68.76	76.20	78.40	81.70	91.70	91.90	92.20	92.40	91.70	90.20
13	20	1770	65.30	69.54	75.90	77.74	80.50	93.10	93.22	93.40	93.56	93.00	91.70
33	40	1780	75.00	78.20	83.00	84.20	86.00	94.30	94.38	94.10	94.10	94.10	93.60
77	100	1780	80.00	82.40	86.00	86.40	87.00	95.80	95.88	96.00	96.24	95.40	95.00
130	200	1785	76.00	79.20	84.00	84.80	86.00	96.20	96.32	96.50	96.62	96.20	95.80

Non-Rotating Loads

For non-rotating loads we are **assuming** Eff = 100% and the PF is **assumed** to be 85%.

The **assumed** 85% PF could be too low as it is easy to find PF references as follows.

Incandescent lamps & heaters ------------ 1.0
Fluorescent & Merc. Vapor lamps ------ 0.5 - 0.95

Therefore it might be more accurate to use a PF of 90% or higher depending on the number and size of lights and heaters.

ELL... Cont.

Adding in more data to the load list.

Row	ID	Description	P&ID	Voltage	BK HP	KVA	HP	MODE	D	LF	PF	EFF
1	P-101A	Bottoms Sump Pump	D-101-10001A	460	7		10	C	100%	70.00%	76.20%	92.20%
2	P-101B	Bottoms Sump Pump	D-101-10001A	460	7		10	S	0%	70.00%	76.20%	92.20%
3	P-102A	Bottoms End Pump	D-101-10001A	460	13		20	C	100%	65.00%	79.22%	92.75%
4	P-102B	Bottoms End Pump	D-101-10001A	460	13		20	S	0%	65.00%	76.22%	92.75%
5	P-103A	Recycle Pump	D-101-10001B	460	77		100	C	100%	77.00%	86.40%	95.78%
6	P-103B	Recycle Pump	D-101-10001B	460	77		100	S	0%	77.00%	86.40%	95.78%
7	P-104	Sump Pump	D-101-10002C	460	33		50	I	10%	66.00%	85.22%	93.08%
8	P-105	Sump Bottoms Pump	D-101-10003A	460	130		200	I	15%	65.00%	88.10%	96.76%
9	HTR-001	Heater 001	D-102-10001A	480		50		I	20%	100%	85%	100%
10	HTR-002	Heater 002	D-102-10001B	480		75		I	25%	100%	85%	100%
11	LP-001	Lighting Panel		480		50		I	50%	100%	85%	100%
12	LP-002	Lighting Panel		480		50		I	50%	100%	85%	100%
13	UPS-001	Inst UPS		480		45		C	3%	100%	85%	100%
14	DC-001	DC Power		480		30		C	3%	100%	85%	100%
15	FDR-001A	Control Building Power		480		400		I	40%	100%	85%	100%
16	FDR-001B	Control Building Power		480		400		I	40%	100%	85%	100%
17	LP-003	Lighting Panel		480		20		I	100%	100%	85%	100%
18	LP-004	Lighting Panel		480		20		I	100%	100%	85%	100%
19	HVAC-001	HVAC Unit #1		480		100		I	75%	100%	85%	100%
20	HVAC-002	HVAC Unit #2		480		100		I	75%	100%	85%	100%

480V MCC's

480V MCC's, bus duct/or feeder cables are sized by following NEC 430:24 Several Motors or a Motor(s) and Other Load(s) for the feeder conductors. That also dictates the 480V step-down xfmr. It better be able to provide for the load.

480V MCC's come in standard sizes (depending on vendor). 600A ,800A, 1200A, 1600A, 2000A, 2500A, 3200A, & 4000A

On a greenfield project I would go up to 80% of ampacity rating. Brownfield is up to 90% of ampacity rating.

Also depends on available physical space.

480V MCC's... Cont.

So, what is your design criteria? What value are you going to use to size the 480V MCC? Below are two possible options.

What does your design criteria document say?

$$A(MCC) > MNRL + (MNRL \times 10\%)$$

$$A(MCC) > MD$$

Note: Totally Connected Load (TCL) is not part of this calculation.

480V SWGR

Say I have four 480V MCC's, each with a MD of 880A. The EPC people say go with 1200A MCC's, I selected 1600A because that is standard at the facility.

The EPC says the standard approach is to use 480V swgr in a M-T-M configuration to power the MCC's.

The EPC people put 2 X MCC's on side 'A' and 2 X MCC's on side 'B' of the 480V swgr. **The goal is to continue balancing out the loads**. Now, how to size the swgr bus?

a. Bus = 4 * 1600A = 6,400A - do they make this???

b. Bus = 4 * 1200A = 4,800A - go with 5,000A bus

c. Bus = 4 * 880A = 3,520A - 3,600A is close so go with 4,000A bus

The End.

Thank you for your attention and

are there any questions?